Luigi Mittone and Andrew Musau

Communication, sequentiality and strategic power. A prisoners' dilemma experiment

CEEL Working Paper 3-16

Cognitive and Experimental Economics Laboratory

Via Inama, 5 38100 Trento, Italy

http://www-ceel.economia.unitn.it
tel. +39.461.282313

Communication, sequentiality and strategic power
A prisoners' dilemma experiment

Luigi Mittone[⊗] and Andrew Musau[⊙⊘]

[⊗]DEM-CEEL, University of Trento
[⊙]School of Social Sciences, University of Trento
[⊘]Faculty of Economics and Social Sciences, University of Agder

Abstract

One shot two-player sequential game experiments are characterized by an asymmetry in the observed payoffs of participants. In the ultimatum game, for example, the distribution favors first-movers, whereas in the investment game, it favors second movers. A comparison to sequential move games are symmetric simultaneous move games, which entail symmetry in actions and payoffs. We experimentally examine the role of first-mover anticipated communication on the inter-player strategic power dynamics that exist in a symmetric simultaneous move prisoners' dilemma, and a sequential move investment game, and show that such communication has a significant effect in inducing payoff asymmetries in symmetric games.

Keywords: strategic power, communication, prisoners' dilemma, investment game, experiment

JEL classification: C72, C91

1 Introduction

In two-player sequential game experiments, there is usually an asymmetry in the observed payoffs of players. For example, the average distribution of stakes on offer favors first-movers in the ultimatum game (see, for example, Güth *et al.*, 1982; Cameron, 1999; Henrich, 2000; Andersen *et al.*, 2011). A meta-analysis of over 30 standard ultimatum game experiments shows that the average first-mover offer to the second-mover is 40 percent of the pie, and this share is even smaller for larger pie-sizes. Concurrently, second-movers only frequently reject offers of less than 20 percent, independent of the size of the pie (Oosterbeek *et al.*, 2004). In the investment game, on the other hand, the picture is reversed and the distribution of final payoffs favors second-movers (refer to Berg *et al.*, 1995; Willinger *et al.*, 2003; Buchan *et al.*, 2008). Based on a meta-analysis of over 130 investment game experiments, Johnson and Mislin (2011) find that the average fraction of first-mover endowment sent to second-movers is 50 percent, whereas the average proportion sent by second-movers to first-movers is 37 percent. In the usual multiplier condition where the amount sent by the first mover is trebled, it can be shown that for any positive endowment, this ratio will always lead to higher average payoffs for second movers.[1]

Differences in average payoffs may proxy strategic power, and have been shown to influence how experimental participants value positions in two-player sequential games. In an earlier study of the ultimatum game, Güth and Tietz (1986) employed the second-price auction in an experiment eliciting position values in the game, and found the position of first-mover is twice as valuable as that of second-mover. Other studies such as Hoffman *et al.* (1994) have considered the strategic first mover advantage in the ultimatum game as implicit, allowing experimental participants to compete for the position of first mover in

[1] Denote the initial endowment amount as π where $\pi > 0$. The 50:37 ratio implies that in cases where the second mover is allowed to send part of her endowment, her final payoff is 1.575π (i.e. $0.63(\pi + (3 \times 0.5\pi))$, compared to 1.425π (i.e. $0.5\pi + 0.37(\pi + (3 \times 0.5\pi))$ for the first mover. When the second mover cannot send her endowment (which is the standard case), the difference is even more pronounced, with the first mover having a final payoff of 1.055π (i.e. $0.5\pi + 0.37(3 \times 0.5\pi)$), compared to 1.945π (i.e. $\pi + 0.63(3 \times 0.5\pi)$) for the second mover.

an entitlement condition, as opposed to that of second mover.

One variable that has been observed to influence the first-mover-second-mover payoff asymmetry in sequential games is pre-play communication. In trust games, Charness and Dufwenberg (2006) argue that communication in the form of promises from second movers enhance cooperation due to "guilt aversion". Second movers promise to cooperate conditional on first movers cooperating. In a large number of cases, first movers do cooperate, and second movers are thus bound to make good on their promises because failure to do so triggers a psychological cost in terms of guilt. In dictator games, where the first mover has absolute power and the second mover is obliged to accept whatever fraction of initial endowment that is allocated, Andreoni and Rao (2011) show that communication in the form of requests from second movers is significant in increasing donations. For them, communication from the second mover to the first mover increases the first mover's empathy with the second mover.

In both studies above, among a list of others in the literature, explanations emphasize the strategic role of communication in enhancing pro-social behavior, and thereby influencing payoff asymmetries in two-player sequential game experiments. However, a lagging question that remains is whether non-strategic communication is just as efficient in inducing similar outcomes. Along these lines, Roth (1995) showed that in a two-player bargaining game, if experimental participants are not allowed to discuss the bargaining game at hand, then this results in significantly higher levels of cooperation between bargaining parties compared to the absence of communication, but not significantly different to when communication is strategic. However, Roth relied on face-to-face communication, and subsequent studies have emphasized the need to include a visual-identification-only treatment in face-to-face communication experiments, to detect any identification-based confounds. Bohnet and Frey (1999) showed that in the dictator game, mutual identification, which entails the first- and second-mover visually identifying each other but no verbal communication, results in significantly higher first-mover amounts allocated relative to no communication and anonymity, but not significantly different to communication (i.e. where participants both visually identify each other and communicate verbally). For Bohnet and Frey, identification strengthens social or cultural propensities for fairness and decreases social distance, thereby allowing the emergence of empathy for the first mover in the dictator game.

To obtain clean data on the effect of communication, this study employs written anonymous communication. Additionally, so as not to explicitly constrain the content of communication as in Roth (1995), we propose changing the sequence of communication so that its effect is non-strategic. Therefore, communication occurs after the first mover has made a binding decision, but before the second mover has made any decisions. Communication thus cannot change the first-mover's decision in the period that it occurs, and this is common knowledge to both the first- and second-mover. We distinguish between two communication forms: one-sided communication from the second mover to the first mover, and two-sided-communication.

A natural comparison to sequential games, where resulting first-mover-second-mover payoff asymmetries are interpreted as strategic power differences, are simultaneous move symmetric games. Such games are characterized by symmetry of payoffs and actions, and no player has a strategic power advantage. In experiments involving the games, there is no distinction between row- and column-participants, as defined in the normal form representations of the games. Thus, the experimentalist will usually collect responses of paired participants and pool them when conducting subsequent analysis, signaling an implicit belief that the row and column roles are equivalent. We thus choose a simultaneous move prisoners' dilemma to represent a balanced strategic power environment. The logical complement to the prisoners' dilemma is the sequential prisoners' dilemma (a version of Kreps' 1990 trust game). However, we choose a sequential move investment game, since it is very similar to the sequential prisoners' dilemma, and it is the standard measure of trust in the experimental economics literature. Furthermore, it allows us to collect more detailed data on the behavior of the second mover using the strategy method (Selten, 1967).

The investment game can be considered a form of continuous prisoners' dilemma, and we calibrate payoffs in the game such that all payoff pairs in the prisoners' dilemma can be obtained by executing a particular sequence of play. However, there is a fundamental difference between the two games. As we have suggested above for symmetric simultaneous move games, in the prisoners' dilemma, there is no first-mover and second-mover distinction that is present in the investment game due to symmetry of actions and payoffs. Part of the reason behind why the second-mover has more strategic power in the investment game is the fact that following the first-movers move, the game is effectively a dictator game in which the second-mover decides how to allocate her total wealth between herself and the first-mover.[2]

Introducing our communication sequence to the prisoners' dilemma allows us to determine which set of players move first, and which set move second. Even though, temporally, this allows us to categorize first-movers and second-movers in this game, it still remains a simultaneous move game because what is of strategic importance is the information that players posses about actions of other players, which is never revealed before play concludes. Furthermore, communication in theory allows the first-mover to reveal her action to the second mover. However, there is always an incentive not to reveal the truth, which is apparent to the second mover. Thus, unlike pure coordination games with a dominant Pareto-efficient Nash equilibrium where our sequence of communication would allow players to coordinate on this equilibrium, in the prisoners' dilemma this would not occur.

We show that communication has a significant effect in inducing payoff asymmetries in two-player symmetric games where a priori, no player has an apparent power advantage. In the absence of communication, as we would expect, outcomes do not differ between (row) first- and (column) second-movers in the prisoners' dilemma, and there are no payoff asymmetries. However, first-movers

[2]The term "dictator" in the dictator game explicitly hints at the extreme situation where one player (the allocator) has absolute power.

behave more cooperatively in the presence of two-sided communication relative to either the absence of communication, or one-sided communication. Second movers on the other hand do not behave as cooperatively in the prisoners' dilemma with two-sided communication, thereby resulting in a payoff advantage accruing to them. The sequential structure of the investment game in the absence of communication results in significantly different outcomes for first- and second-movers, in line with findings from previous studies. The results of communication for first movers mainly mirror those from the prisoners' dilemma where we observe that two-sided communication induces higher offers. One-sided communication results in significantly lower levels of cooperation relative to either no-communication, or two-sided communication, a result that mirrors that of Andreoni and Rao (2011) in the dictator game.

The paper is organized as follows: Sec. 2.1 presents the experimental design. Sec. 2.2 outlines our behavioral predictions. Sec 2.3 describes the experimental procedures and protocols. Sec 3 presents the results. Eventually, Sec. 4 provides a discussion and concludes.

2 Method

The introduction of communication changes the structure of the investment game and prisoner's dilemma by adding a move in the extensive form representations of the games. The following experimental design describes the games and details the experimental treatments and protocols.

2.1 Experimental design

In our setting, X represents the first-mover in the investment game, and row player in the prisoners' dilemma. Correspondingly, Y represents the second-mover, and column player, respectively.

We employ the strategy method to elicit the full strategy vector of Y in the investment game. In this game, X chooses an amount x to send to Y

from an endowment of 10, in units of 1, resulting in eleven possible amounts: $x \in \{0, 1, 2, \ldots, 10\}$. Before being forwarded to Y, the amount x is multiplied by a factor of 2, so that Y receives $2x$. Y, also endowed with 10, decides on an amount y to send to X from her total wealth, that is, $10 + 2x$. The only restriction that we impose is that y must be an integer within the bounds ($y \in \mathbb{Z}$ such that $0 \leq y \leq 10 + 2x$). A strategy of Y assigns y to each x choice of X, and is an eleven-element vector collected by having Y fill in a table similar to Table 1. The payoffs to X and Y, respectively, are:

$$\pi^X = 10 - x + y \tag{1}$$

$$\pi^Y = 10 + 2x - y. \tag{2}$$

Table 1: Investment game with strategy method: Y's decision task

x	0	1	2	3	4	5	6	7	8	9	10
$2x$	0	2	4	6	8	10	12	14	16	18	20
$10 + 2x$	10	12	14	16	18	20	22	24	26	28	30
y	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

In the prisoners' dilemma, X chooses one of two actions: $a_1^X = up$, or $a_2^X = down$. In turn, Y chooses one of two actions: $a_1^Y = left$, or $a_2^Y = right$. An outcome of the game is an action pair, which we denote a, where: $a^1 = (a_1^X, a_1^Y)$, $a^2 = (a_1^X, a_2^Y)$, $a^3 = (a_2^X, a_1^Y)$, and $a^4 = (a_2^X, a_2^Y)$. The payoffs to X and Y, respectively, are: $\pi^X = 15$ and $\pi^Y = 15$ if the outcome is a^1; $\pi^X = 0$ and $\pi^Y = 30$ if a^2; $\pi^X = 30$ and $\pi^Y = 0$ if a^3; and, $\pi^X = 10$ and $\pi^Y = 10$ if a^4. The normal form representation in Figure 1 exhibits payoffs in the game. As illustrated in the 2×2 matrix, the prisoners' dilemma is symmetric in the sense that payoffs for playing a particular action depend only on the other actions employed, not on who is playing them. We rename actions in this game to explicitly distinguish between the actions of the row player and the column player.

	left	*right*
up	15, 15	0, 30
down	30, 0	10, 10

Figure 1: Payoffs in the prisoners' dilemma

Before Y makes her decision(s), but after X has made a binding decision, there is a communication phase in each of the game experiments. We distinguish three treatments:

NC (No Communication): The standard investment game with strategy method, and prisoners' dilemma with a time gap between X's decision, which occurs first, and Y's decision(s).

OSC (One-Sided Communication): Following X's decision, Y can choose to unilaterally communicates to X in writing for two minutes, after which Y makes her decision(s).

TSC (Two-Sided Communication): Following X's decision, both X and Y can choose to communicate to each other in writing for two minutes, after which Y makes her decision(s).

The treatments are implemented in a between-subject design. However, due to the minimal decision tasks in the prisoners' dilemma (one decision per participant per period), we implement both games within subjects. Thus, participants in one session take part in a investment game followed by a prisoners' dilemma.

Payoff Equivalence

Our design of the games is such that all payoff pairs in the prisoners' dilemma can be obtained by executing a particular sequence of play in the investment game. This is summarized below:

- If X chooses $x = 10$ and Y chooses $y = 15$ in the investment game, then the payoff corresponds to outcome a^1 in the prisoners' dilemma;

- If $x = 10$ and $y = 0$, outcome a^2;

- If $x = 10$ and $y = 30$, outcome a^3;

- and, if $x = 0$ and $y = 0$, outcome a^4.

2.2 Behavioral predictions

The rational selfish prediction of behavior in the investment game and prisoners' dilemma is represented by the last combination of payoffs above ($x = 0$ and $y = 0$, and outcome a^4, respectively). Applying backward induction to determine the subgame perfect strategy, X evaluates π^Y in Eq. 2 and recognizes that it is declining in y, i.e., $\left(\frac{\partial \pi^Y}{\partial y}\right) < 0$. Anticipating that Y will set $y = 0$, now X's payoff in Eq. 1 becomes $\pi^{X'} = 10 - x$, and she sets $x = 0$ because $\pi^{X'}$ is declining in x, i.e., $\left(\frac{\partial \pi^{X'}}{\partial x}\right) < 0$. An analogous argument holds for Y. In the prisoners' dilemma in Fig. 1, only $a^4 = (down,\ right)$ is a pure strategy Nash Equilibrium outcome since $\pi^X(down,\ right) > \pi^X(up,\ right)$, and $\pi^Y(down,\ right) > \pi^Y(down,\ left)$, implying that neither X nor Y has an incentive to deviate from the outcome.[3] Neither outcome is Pareto efficient; for example, both X and Y are better off if X sends her full endowment and Y returns half of her total wealth in the investment game, and both cooperate in the Prisoners' dilemma ($x = 10$ and $y = 15$, and outcome a^1, respectively). Additionally, under selfish preferences, communication does not influence the predicted outcome.

Numerous studies, however, have shown that participants in one-shot investment game and prisoners' dilemma experiments do not conform to the ra-

[3] In the first quadrant of the matrix, both players have an incentive to deviate from the outcome since $15 > 0$. In the second (third) quadrant, X (Y) has an incentive to deviate since $30 > 10$.

tional selfish prediction.[4] Furthermore, communication has been observed to increase cooperation levels in a wide range of games (see reviews by Crawford, 1998; Roth, 1995). Based on previous investment game and prisoners' dilemma studies, and the symmetry property of the prisoners' dilemma, we predict the following outcomes for the NC treatment

H1 Some X and Y participants will send positive amounts in the investment game, but average final payoffs of Y will be higher.

H2 Some X and Y participants will choose the cooperative action in the prisoners' dilemma, but there will be no difference in average final payoffs.

The fact that cooperative behavior emerges even in the absence of communication, and under double-blind conditions (see for example, Berg *et al.* (1995), in the investment game) suggests that trust and reciprocity is a social norm. In the investment game, the first-mover signals trust by sending a positive amount, whereas the second mover signals trustworthiness by reciprocating trust. The introduction of communication additionally influences the trust and reciprocity dynamics in the investment game. Charness and Dufwenberg's study reviewed in the introductory section shows how written pre-play communication of a strategic nature can induce higher contributions by first movers, and enhance cooperative behavior generally. Our design rules out effects of strategic communication on behavior, so to enable us formulate predictions for the communication treatments, we rely on a few studies have implemented a communication sequence similar to ours.

Xiao and Houser (2005) allow the second mover to attach a written message to her accept/ reject decision in the ultimatum game after receiving a binding offer from the first mover. They observe that first mover offers do not differ to the standard condition, but second movers reject unfair offers significantly less frequently. Thus, it appears that second movers expression of negative

[4] In repeated games, the folk theorem asserts that cooperative behavior can emerge and be sustained if the game has an unknown end-point, and players are sufficiently patient. Therefore, with frequent repeated and non-anonymous interaction, socially beneficial behavior may endogenously develop as a result of reputation (and the ensuing threat of punishment).

emotions for what they perceive to be unfair offers decreases the likelihood that they reject such offers. This result suggests that communication supplements costly punishment by providing an additional medium where an aggrieved party can express her emotions. In the dictator game, Ellingsen and Johannesson (2007) find that first movers (allocators) if anticipating written messages from second movers (recipients) after their allocation decisions, will act more other-regarding, with donations in the communication treatment being significantly higher to donations in the standard treatment. Xiao and Houser (2009) replicate this result, and speculate that allocators have a preference for avoiding written expression of disapproval, or negative emotions, which explains their enhanced pro-social behavior.

An additional hypothesis articulated by Hoffman *et al.* (1996) is that communication induces cooperative behavior by reducing the social distance between interacting parties. In the absence of communication and with anonymity, there is social isolation of an individual's decision. On the other hand, with communication, there is a social interaction, and individuals potentially have to justify their past and future choices. In dictator game studies (for example, some of those reviewed in the introductory section), decreasing social distance has been shown to increase contributions by first movers. However, since second movers unilaterally communicate to first movers in our OSC treatment, if they choose not to exercise this right (since communication is optional in the experiments), then this leaves open the possibility that communication will not reduce the social distance between pairs of participants. In the TSC treatment, for this to happen, it must be the case that both paired participants choose not to communicate simultaneously, and the odds of this happening are small. Therefore, we expect a less strong communication effect in OSC relative to TSC. Based on the anticipated written communication results highlighted, and the social distance hypothesis, we formulate the following hypothesis for the communication treatments:

H3 X and Y participants will act more cooperatively in TSC relative to either

OSC or NC in the investment game and prisoners' dilemma.

H4 X and Y participants will act more cooperatively in OSC relative to NC in the investment game and prisoners' dilemma.

Cooperation rates do not automatically translate to differences in payoffs between players because it is possible to observe high levels of cooperation in one treatment relative to another, whereas within treatments, no differences in first- and second-mover payoffs are observed. Therefore, we formulate the following hypothesis regarding payoff asymmetries in the investment game:

H5 Differences in the average payoffs of X and Y participants will always favor Y participants, but the largest difference will be observed in the NC treatment, and the smallest difference in the TSC treatment.

Therefore, the above hypothesis states that higher levels of cooperation between players in TSC will reduce the observed asymmetry in the average payoffs of the first- and second-movers. By virtue of symmetry of actions and payoffs, we do not expect that there will be an asymmetry in the average payoffs of first- and second-movers in the prisoners' dilemma within each treatment, but based on the predicted levels of cooperation, we expect that average payoffs will differ between treatments.

H6 There will be no difference in the average payoffs of X and Y participants within each treatment, but average payoffs will be highest in TSC and lowest in NC.

2.3 Experimental procedures

Experimental sessions took place at the Cognitive and Experimental Economics Laboratory (CEEL), at the University of Trento. Participants were undergraduate students from the institution were recruited from an in-house list of volunteers who had signed up to be considered for future participation in experiments. Three sessions representing the aforementioned treatments were conducted, and a session was divided into two parts, each of five periods. The first part of a session involved play of the investment game with strategy method, while the second part, the prisoners' dilemma.

Upon arrival at the laboratory, each participant was randomly assigned the role of X or Y, and maintained this role for the remainder of the session. Before the start of each part of a session, participants were given a set of written instructions to read through privately (see Appendix A.1 for the translated text). A member of the experimental staff thereafter read aloud the instructions, and once it was ascertained that everyone had understood them, the experiment started. A single-blind design was utilized, and the $X - Y$ pairs across periods were determined using a stranger matching protocol.

At the end of each part of a session, one of the five periods was randomly selected for payment. Each part of a session accounted for half of the earnings from the session, alongside a show-up fee of € 2.50. At the end of the session, Experimental Currency Units (ECU), the exchange medium used in the experiment, were converted to Euros at a rate of 3 ECU= € 1. Participants received their dues in private prior to leaving the laboratory.

3 Results

3.1 Descriptive statistics

3.1.1 Choices of X

We begin with an overview of the choices of X participants across the three treatments. Figure 2 summarizes the distribution of individual level average amounts sent by first-movers in the investment game, and the proportion of row-players choosing the cooperative action in the prisoners' dilemma.

In the former, the average amount is about twice as high in TSC compared to NC and OSC. The non-parametric Wilcoxon rank-sum test indicates that this difference (from pair-wise comparisons) is statistically significant ($p < 0.001$).

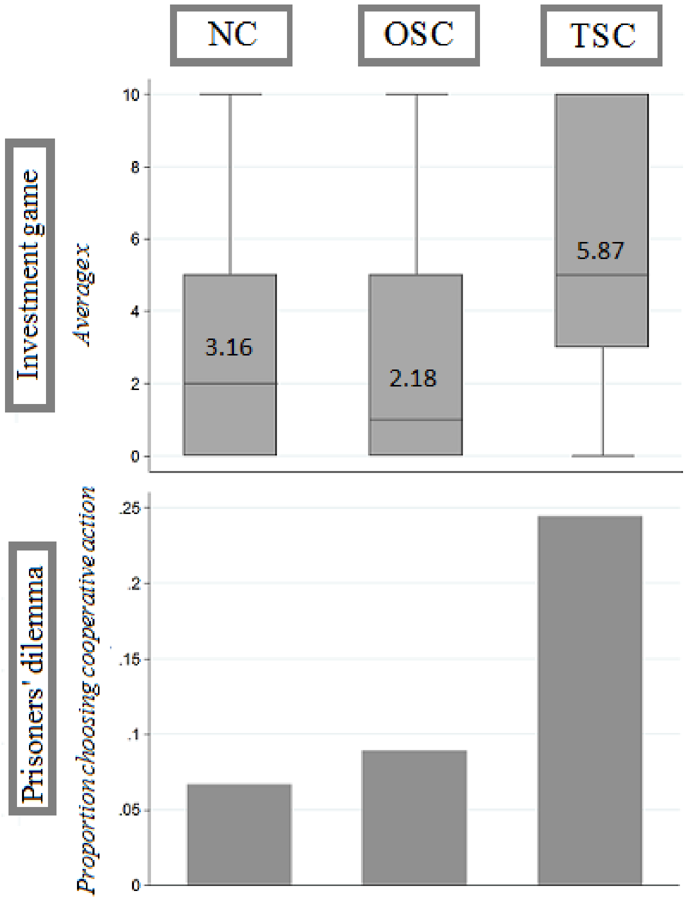

Figure 2: Choices of X participants (average at individual level for investment game). Figures within boxes represent mean values.

However, there is no significant difference in average amounts in NC and OSC ($p = 0.123$). Correspondingly, the proportion of row player participants who choose the cooperative action $a_1^X = up$ in the prisoners' dilemma is higher in TSC (approx. 24%) compared to NC and OSC (approx. 7% and 9%, respectively). Wilcoxon rank-sum tests confirm that TSC and NC, and TSC and OSC differ ($p = 0.021$, and $p = 0.049$, respectively), whereas NC and OSC do not differ ($p = 0.696$).

Observation 1 *X participants behave more cooperatively in the presence of two-sided communication. One-sided communication has no effect on the be-*

havior of X relative to no communication.

The above result establishes some consistency with regards to the effect of communication on the behavior of X participants across both games. Whether or not two-sided communication results in more cooperation generally, depends also on the behavior of Y participants analyzed below.

3.1.2 Choices of Y

Figure 3 exhibits the distribution of individual-level average choices of Y in the investment game conditional on potential choices of X.

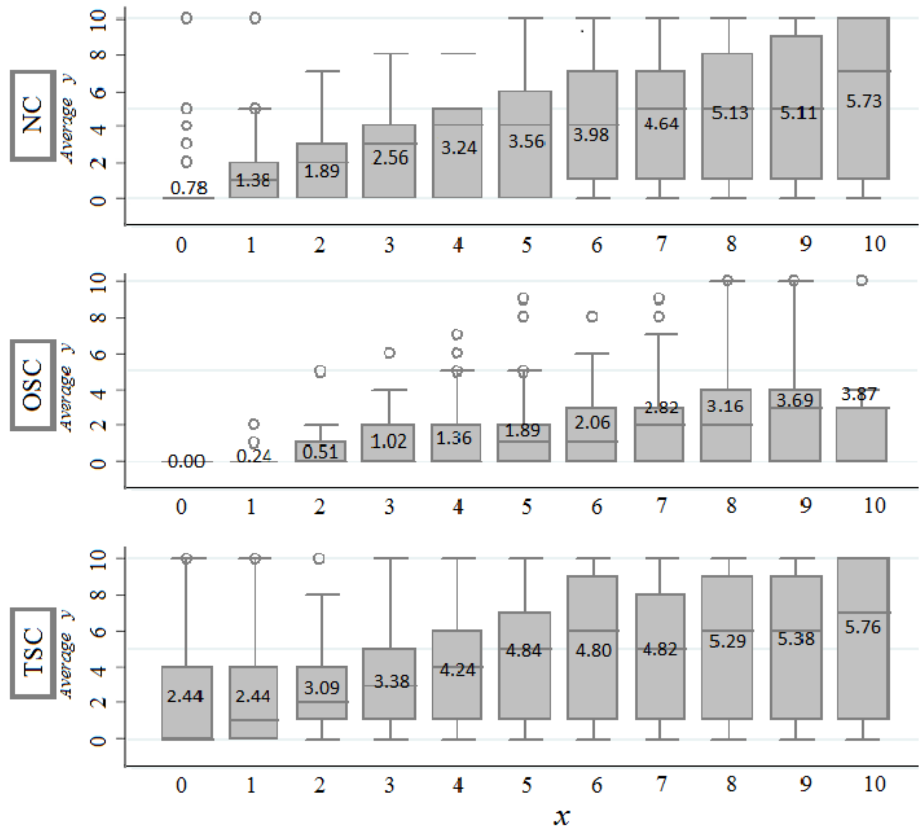

Figure 3: Choices of Y participants in the investment game (average at the individual level). Figures within boxes represent mean values.

For low and intermediate levels of x (i.e., $0 - 3$ and $4 - 6$, respectively), average amounts are generally higher in TSC relative to either NC or OSC, and

NC relative to OSC, whereas for high levels of x (i.e., $7 - 10$), average amounts are higher in both NC and TSC relative to OSC. A series of Wilcoxon rank-sum tests indicate that the differences are significant for low and intermediate levels. For high levels, the rank-sum tests show that choices of Y do not differ between OSC and TSC, but differ between NC and OSC and between NC and TSC.

Observation 2 *The effect of two-sided communication is conditional on the level of trust displayed by X: For low levels, Y participants cooperate more relative to no communication, whereas behavior does not differ for high levels.*

Observation 3 *One-sided communication induces lower-contributions relative to either no communication or two-sided communication, irrespective of the level of trust displayed by X.*

The proportion of column-player participants choosing the cooperative action $a_1^Y = left$ in the prisoners' dilemma is exactly equal in NC and TSC ($\approx 9\%$), and slightly lower in OSC ($< 5\%$). Wilcoxon rank-sum tests show that the difference between OSC and either of the other two treatments is not significant ($\rho = 0.170$).

Observation 4 *Generally, Y participants display low levels of cooperation in the prisoners' dilemma, with no behavioral differences across treatments.*

3.1.3 Within treatment $X - Y$ payoff asymmetries

Figure 4 displays the average payoffs of X and Y participants in the prisoners' dilemma across treatments.

Wilcoxon rank sum tests indicate that there is no asymmetry in X and Y average payoffs in NC ($\rho = 0.561$), whereas average payoffs are significantly higher for Y participants in both OSC and TSC ($\rho = 0.059$ and $\rho = 0.005$, respectively). A between treatment comparison of payoffs for X participants reveals that average payoffs are just only higher in NC relative to TSC ($\rho = 0.099$). For Y participants, average payoffs are higher in TSC relative to NC ($\rho = 0.030$).

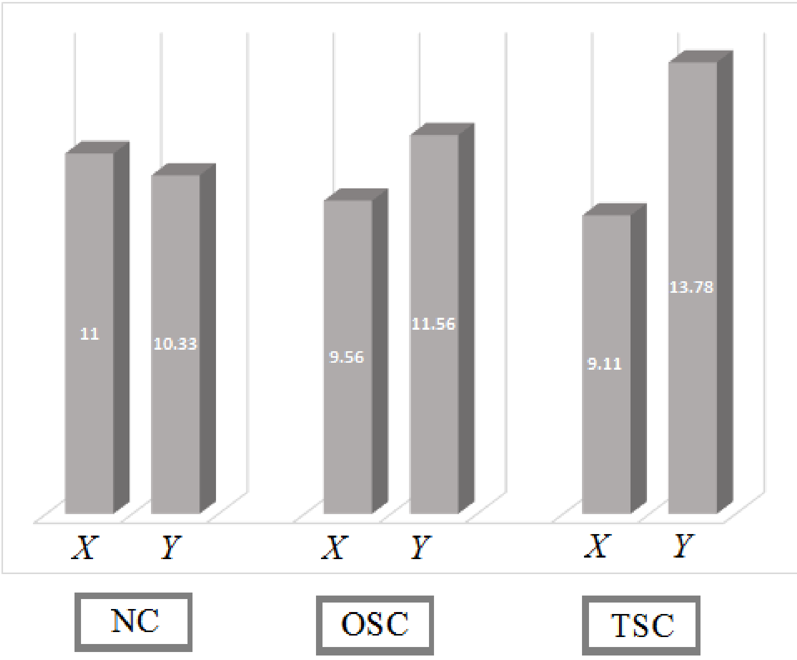

Figure 4: Average payoffs of X and Y participants across treatments in the prisoners' dilemma. Figures within boxes represent ECU amounts.

Observation 5 *Average payoffs of row and column participants do not differ in the absence of communication in the prisoners' dilemma. However, with communication, average payoffs are higher for column participants.*

Figure 5 exhibits the average payoffs of X and Y participants in the investment game across treatments.

Wilcoxon rank sum tests indicate that average payoffs are significantly higher for Y participants relative to X participants in all three treatments ($\rho < 0.001$). A between treatment comparison of average payoffs of X participants reveals that they differ between NC and OSC ($\rho < 0.001$), OSC and TSC ($\rho < 0.001$), but not between NC and TSC ($\rho = 0.112$). For Y participants, average payoffs are higher in TSC relative to NC and OSC ($\rho < 0.001$), but do not differ between NC and OSC ($\rho = 0.254$).

Observation 6 *Average payoffs are higher for second movers relative to first movers in the investment game across all three treatments.*

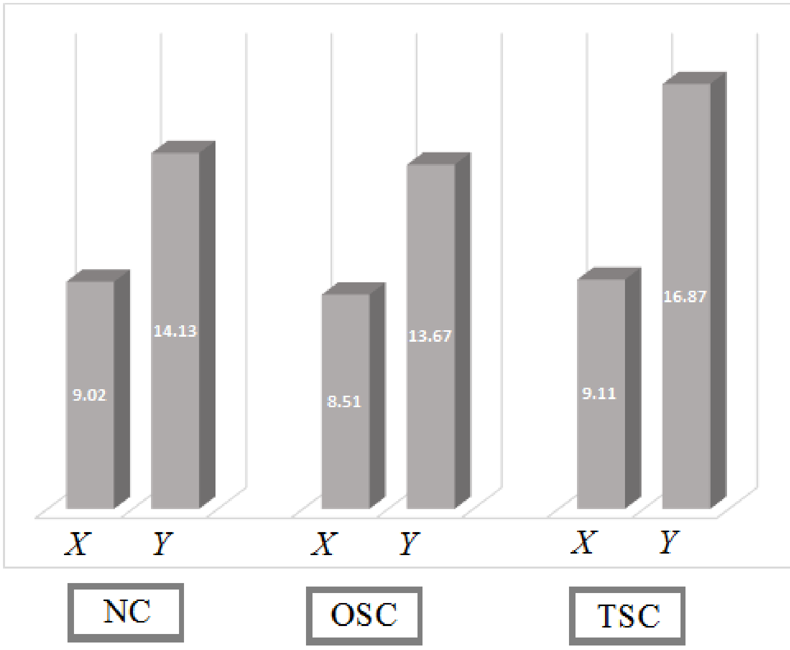

Figure 5: Average payoffs of X and Y participants across treatments in the investment game. Figures within boxes represent ECU amounts.

In relation to our behavioral predictions in Sec. 2.2, the results support hypotheses H1-H2. Hypothesis H3 is supported for X participants, but not for Y participants. Hypothesis H4 is completely rejected. Hypothesis H5 is supported with the following qualification: differences in average payoffs are greatest in TSC, and do not vary much between OSC and NC. Apart from there being no differences in $X - Y$ payoffs in NC, and average Y payoffs being significantly higher in TSC , Hypothesis H6 is overwhelmingly rejected.

3.2 Regression analysis

We further analyze the effect of communication on participants' decision to cooperate in the prisoners' dilemma, examining whether there are differences between row- and column-player participants' decisions across treatments. Furthermore, exploiting the broader range of data on the intended behavior of Y participants across all levels of X offers (provided by the strategy method), we investigate the effect of communication on reciprocity. Our emphasis in the investment game is not on how communication affects how much Y participants reciprocate, but rather on how it affects their decision to reciprocate. Therefore, we define an indicator outcome variable

$$y^* = \begin{cases} 1 & \text{if } y \geq x \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

Our estimation model thus takes the form

$$p_i = \text{Probability}(y^* = 1) = f(\beta_0 + \beta' Q_i) \tag{4}$$

where

$$\beta' Q_i = \beta_1 \text{OSC}_i + \beta_2 \text{TSC}_i + \beta_3 \text{x\_INT}_i + \beta_4 \text{x\_HIGH}_i + \beta_5 \text{Period}_i.$$

The specification controls for the main effects of the treatments (where NC is the baseline category), the impact of experimental periods, and the level of trust displayed by X (where x_INT is an indicator variable that takes the value one if $x \in [4, 6]$, x_HIGH for $x \in [7, 10]$, x_LOW for $x \in [0, 3]$; and zero otherwise). We estimate a random intercept binomial logit model using GLLAMM (Stata), where we account for nested random effects arising from repeated choices of participants and their random assignment into matching groups at each experimental period. Table 2 presents estimates of the model. Beginning from a very general model (column 1), we eliminate the insignificant interaction effects and are left with the desired model in column 2.

The results show that one-sided communication decreases the probability of Y reciprocating relative to no communication, whereas two-sided communication increases this probability. Relative to one-sided communication, two-sided communication significantly increases the probability of Y reciprocating (see W-st1). Both intermediate and higher levels of X offers decrease the probability

Table 2: Communication and Reciprocity (Random-intercept logit)

Reciprocity∼	Coeff (Std. Err.)	
	(1)	(2)
(Intercept)	1.081 (0.569)*	1.173 (0.556)**
OSC	-2.364 (0.325)***	-2.456 (0.303)***
TSC	0.530 (0.299)*	0.334 (0.158)**
x_INT	-0.526 (0.286)*	-0.545 (0.206)***
x_HIGH	-0.972 (0.270)***	-1.188 (0.196)***
Period	-0.227 (0.163)	-0.226 (0.162)
*OSC*x_INT*	0.863 (0.441)*	0.882 (0.394)**
*OSC*x_HIGH*	1.296 (0.416)***	1.511 (0.372)***
*TSC*x_INT*	-0.046 (0.413)	
*TSC*x_HIGH*	-0.440 (0.386)	
*W-st*1	81.27***	82.84***
*W-st*2	13.04***	37.70***
Log likelihood	-720.5	-721.4

*W-st*1 : Wald statistic for the hypothesis *OSC= TSC*
*W-st*2 : Wald statistic for the hypothesis *x_INT= x_HIGH*
***(0.01);** (0.05);* (0.1) significance level

of Y reciprocating relative to low levels of X offers, with higher offers having a stronger effect (which is significant also relative to one-sided communication, indicated by W-st2). The interaction between one-sided communication and the offer levels of X are significant, whereas the interactions with two-sided communication are not. The probability of Y reciprocating decreases with time, but the effect is not significant.

Observation 7 *Reciprocity of Y participants depends both on the form of communication and the trust level displayed by X. Two-sided communication has a positive effect, and one-sided communication has a negative effect. Higher participant X offer levels decrease the likelihood of reciprocity.*

To analyze the choice to cooperate in the prisoners' dilemma, we specify the following model:

$$p_i = \text{Probability}(a_1^j = \text{Cooperate}) = f(\beta_0 + \beta' S_i); \;\; j \in \{X, Y\} \tag{5}$$

where

$$\beta' S_i = \beta_1 \text{OSC}_i + \beta_2 \text{TSC}_i + \beta_3 \text{X\_Part}_i + \beta_4 \text{Period}_i.$$

X_Part in the specification above is a participant X indicator variable which allows us to compare differences between cooperative behavior of X and Y participants. As previously stated, the cooperative action is a_1^X = up for X participants (row-players), and a_1^Y = left for Y participants (column players).

Table 3: Communication and Cooperation (Random-intercept logit)

Cooperate∼	Coeff (Std. Err.)	
	(1)	(2)
(Intercept)	-1.619 (0.789)**	-2.268 (0.755)***
OSC	-1.576 (1.179)	-0.400 (0.638)
TSC	-0.001 (0.787)	0.999 (0.530)*
X_Part	-0.361 (0.884)	0.887 (0.520)*
Period	-0.411 (0.195)**	-.397 (0.187)**
*OSC*X_Part*	1.925 (1.452)	
*TSC*X_Part*	1.777 (1.104)	
*W-st*1	2.01	6.85**
Log likelihood	-77.6	-79.2

*W-st*1 : Wald statistic for the hypothesis *OSC*= *TSC*
***(0.01);** (0.05);* (0.1) significance level

Beginning with the very general model in column 1, we eliminate insignificant interactions until we are left with the desired model in column 2. From the results, we observe that one-sided communication has no significant effect on the probability that a participant chooses the cooperative action in the prisoners' dilemma relative to no communication, whereas two-sided communication increases this probability. In addition, two-sided communication relative to one-sided communication also increases the probability that a participant chooses the cooperative action (see W-st1). Being an X participant increases the probability of choosing the cooperative action relative to being a Y participant. Finally, it emerges that the probability of choosing the cooperative action declines over time as participants acquire more experience.

Observation 8 *The probability of choosing the cooperative action in the prisoners' dilemma is positively related to two-sided communication and being tem-*

porally the first mover, and negatively related to experience.

Our final analysis looks at the effect of communication on how profitable trust is for X participants in the investment game. To measure this profitability of trust, we define the following outcome variable which computes the rate of return on the amount that X forwards to Y.

$$\text{Rate of return (\%)} = \left(\frac{y}{x} - 1\right) * 100; \quad x \neq 0 \tag{6}$$

We estimate a random intercept linear model with the same set of regressors in Table 2, restricting our sample to strictly positive values of y (i.e., $y > 0$).

Table 4: Communication and profitability of trust (random-intercept linear)

Rate of return (%)$\sim$	Coeff (Std. Err.) Reciprocators ($y > 0$)
(Intercept)	55.989 (15.846)***
OSC	-73.244 (15.931)***
TSC	75.206 (12.610)***
x_INT	-59.753 (12.379)***
x_HIGH	-77.884 (11.559)***
Period	-1.162 (4.111)
*OSC*x_INT*	39.255 (20.261)*
*OSC*x_HIGH*	61.491 (19.078)***
*TSC*x_INT*	-52.341 (17.172)***
*TSC*x_HIGH*	-76.055 (16.088)***
W-st1	97.52***
W-st2	46.84***
Log likelihood	-5430.5

W-st1 : Wald statistic for the hypothesis *OSC= TSC*
W-st2 : Wald statistic for the hypothesis *x_INT= x_HIGH*
***(0.01);** (0.05);* (0.1) significance level

The results show that like reciprocity, both one-sided communication, intermediate- and high-offer levels of X (relative to low offer levels) have a negative effect on the profitability of trust, whereas two-sided communication has a positive effect. All interaction terms are significant, implying that effect of communication depends on the level of trust displayed by X, in both cases with higher levels corresponding to stronger effects of communication. Period is not significant, as was the case in Table 2.

Observation 9 *The profitability of trust depends mainly on the same factors that affect reciprocity of Y participants. However, unlike reciprocity, the form of communication interacts with the levels of trust displayed by X.*

4 Discussion

Before delving into other themes, it may be beneficial to first address the main focus of this study which is the strategic advantage that arises from the structure of sequential games, and how communication affects this. As expected, we find that our results for the no communication treatments are consistent with those from previous studies: there are no behavioral differences between first-movers (row players), and second-movers (column players) in the prisoners' dilemma, whereas second-movers are significantly better off (in payoff terms) relative to first-movers in the investment game. However, we observe that once we introduce communication into the mix, first-mover behavior in the investment game does not differ between the no-communication- and one-sided-communication treatments, whereas first-movers make significantly higher offers in the presence of two-sided communication. In the prisoners' dilemma, we also observe a similar pattern: first-movers (row players) choose the cooperative action more than twice as often in the two-sided communication treatment relative to either the one-sided- or no-communication-treatment. This result leaves us to explain why two-sided communication significantly induces first movers to cooperate across both games, whereas one sided communication does not. Previous studies suggest that our communication sequence can account for this pattern of behavior. The anticipated communication findings of Ellingsen and Johannesson (2007) and Xiao and Houser (2009) reviewed under our behavioral predictions (Sec. 2.2) showed that in dictator games, if first movers anticipate written communication from second movers following their allocation decision, their donations are significantly higher relative to the standard no-communication condition. However, unlike the dictator game where the only motivation for the first mover to donate is altruism, it appears from our results that this anticipation effect extends to environments where there are strategic considerations, for example, whether the second mover reciprocates in the investment game, or whether she in turn cooperates in the prisoners' dilemma.

The one-sided communication result for first movers replicates the behavior of second movers under the same condition, and is best addressed in a more general context. Second movers in the prisoners' dilemma choose the cooperative action with significantly less frequency, resulting in no differences in cooperation rates across all three treatments. In the investment game, on the other hand, the effect of two-sided communication is conditional on the first mover's offer level: for low levels ($0 - 30\%$ of endowment), second movers send higher amounts relative to both one-sided and no-communication. However, for high levels ($70 - 100\%$ of endowment), behavior in the two-sided communication treatment does not differ with the no-communication treatment. On the other hand, one-sided communication, relative to either two-sided-communication or no-communication, results in significantly lower amounts sent by second movers. This result that one sided communication leads to the same or lower levels of cooperation relative to no communication replicates what could have been an easily overlooked result by Andreoni and Rao (2011). In their study, they found that in dictator games where the allocator sends a written message to the recipient along with the allocated amount (and the recipient stays silent), the amount allocated is significantly lower relative to all other treatments (no communication, two-sided communication, and one-sided communication from recipient). To summarize this result in a general context, when a decision maker is allowed to unilaterally communicate prior to making her allocation decision, she behaves less other-regarding. Our results additionally suggest that this self-regarding behavior extends to environments where strategic considerations are present, and is not isolated to the dictator game.

We follow Andreoni and Rao's intuition of this result. A better way to think about this is to ask why are cooperation levels higher with two sided communication? Somehow, it must be the case that two-sided communication is affecting the utility function of the decision maker. If we consider an Andreoni and Bernheim (2009) utility function for the decision maker, where utility is split between consumption utility and social utility, two sided communication affects the social utility component. In this framework, the decision maker not only cares about fairness, but also gains additional utility if others perceive her to be fair, and perceptions depend on how much she decides to give. Andreoni and Rao hypothesize that if the allocator unilaterally communicates to the recipient in the dictator game, then this disrupts the empathy-altruism mechanism, or more generally self- and social-signalling. Thus, our replication of Andreoni and Rao's result in a non-dictator-game context suggests that social utility remains an important consideration even in the presence of strategic considerations, such as reciprocity.

The rich data afforded by the strategy method in the investment game allowed us to gain an in depth analysis of how communication affects the reciprocity of second movers, and the profitability of trust, which is dependent on first mover offer levels and the corresponding responses of second movers. We found that intermediate- ($40 - 60\%$ of endowment) and high-first mover offers decrease the probability that second movers reciprocate, as does one-sided communication, whereas two-sided communication increases the probability that second movers reciprocate. The profitability of trust on the other hand is mainly influenced by the same factors, except that the form of communication interacts with the levels of first mover offers, implying that effect of communication is dependent on how much first movers choose to send.

In conclusion, this paper has identified and implemented an experimental design that examines the effect of non-strategic communication form on the strategic advantage that arises from the structure of sequential games. A sequential move investment game, and a simultaneous move prisoners' dilemma were chosen to represent an asymmetric power environment, and a balanced power environment, respectively. Previous studies have shown that second-movers in the investment game are strategically better off in payoff terms relative to first-movers. In the prisoners' dilemma, even though players can make their moves at different points in time applying our communication sequence, symmetry of actions and payoffs, and the information available to players at the time they make their moves implies that there is no strategic advantage to being either a first- or second-mover (i.e., the game is still a simultaneous move game despite the fact that moves are not themselves simultaneous in time). We show that anticipated communication has a significant effect in inducing payoff asymmetries (and hence power differences) in symmetric games. This anticipated communication effect cannot be attributed to the fact that we temporally separate the move of the row- and column-player in the prisoners' dilemma, since the no-communication treatment shows that even with such a separation, in the absence of communication, outcomes do not differ between first- and second-movers.

References

Andersen, S., Ertaç, S, Gneezy, U., Hoffman, M., & List, J. A. (2011). Stakes matter in ultimatum games. *American Economic Review*, **101**, 3427–3439.

Andreoni, J. and Bernheim, D. B. (2009). Social image and the 50-50 norm: A theoretical and experimental analysis of audience effects. *Econometrica/*, **77**(5), 1607–1636.

Andreoni, J. and Rao, J. M. (2011). The power of asking: How communication affects selfishness, empathy, and altruism. *Journal of Public Economics*, **95**(7-8), 513–520.

Berg, J., Dickhaut, J., and McCabe, K. (1995). Trust, reciprocity and social history. *Games and Economic Behavior*, **10**, 122–142.

Bohnet, I., and Frey, B. S. (1999). The sound of silence in prisoner's dilemma and dictator games. *Journal of Economic Behavior and Organization*, **38**, 43–57.

Buchan, N. R, Croson, R. T. A., and Solnick, S. (2008). Trust and gender: An examination of behavior and beliefs in the Investment Game. *Journal of Economic Behavior and Organization*, **68**, 466–476.

Cameron, L. A. (1999). Raising the Stakes in the Ultimatum Game: Experimental Evidence from Indonesia. *Economic Inquiry.*, **37**, 47–59.

Charness, G. and Dufwenberg M. (2006). Promises and Partnerships. *Econometrica*, **74**(6), 1579–1601.

Crawford, V. (1998). A Survey of Experiments on Communication via Cheap Talk. *Journal of Economic Theory*, **78**, 286–298.

Ellingsen, T., and Johannesson, M. (2007). Anticipated verbal feedback induces altrusitic behavior. *Evolution and Human Behavior*, **29**, 100–105.

Güth, W., Schmittberger, R., & Schwarze, B. (1982). An experimental Analysis of Ultimatum Bargaining. *Journal of Economic Behavior and Organization*, **3**, 367–388.

Güth, W. and Tietz, R. (1986). Auctioning ultimatum bargaining positions. How to decide if rational decisions are unacceptable? In: R. W Scholz (eds.), *Current issues in West German decision research* , 173–185. Frankfurt: Verlag Peter Lang.

Henrich, J. (2000). Does Culture Matter in Economic Behavior? Ultimatum Game Bargaining Among the Machiguenga of the Peruvian Amazon. *American Economic Review*, **90**, 973–979.

Hoffman, E., McCabe, K., Shachat, K., and Smith, V. (1994). Preferences, Property Rights and Anonymity in Bargaining Games. *Games and Economic Behavior*, **7**, 346–380.

Hoffman, E., McCabe, K., and Smith, V. L. (1996). Social Distance and Other-Regarding Behavior in Dictator Games. *American Economic Review*, **86**(3), 653–660.

Johnson, N. and Mislin, A. (2011). Trust games: A meta-analysis. *Journal of Economic Psychology*, **32**(5), 865–889.

Kreps, D. M. (1990). Cooperate Culture and Economic Theory. Pp. 90–143, in *Perspectives on positive political economy*, edited by Alt J. and Shepsle K. Cambridge University Press. Cambridge, United Kingdom.

Oosterbeek, H., Sloof, R. and van de Kuilen, G. (2004). Cultural differences in ultimatum experiments: Evidence from a meta-analysis. *Experimental Economics*, **7**, 171–188.

Roth, A. (1995). Bargaining experiments. In J. Kagel and A.E Roth, (Eds.), *The Handbook of Experimental Economics*, pages 253–348. Princeton University Press, Princeton, NJ.

Selten, R. (1967). Die Strategiemethode zur Erforschung des eingeschränkt rationalen Verhaltens im Rahmen eines Oligopolexperimentes. In Sauermann, H., editor, *Beiträge zur experimentellen Wirtschaftsforschung*, 136–168. Mohr Siebeck, Tübingen.

Willinger, M., Keser, C., Lohmann, C., and Usunier J-C., G. (2004). A Comparison of Trust and Reciprocity Between France and Germany: Experimental Investigation Based on the Investment Game. *Journal of Economic Psychology*, **24**, 447–466.

Xiao, E., and Houser, D. (2005). Emotion expression in human punishment behavior. *Proceedings of the National Academy of Sciences*, **102**(20), 7938–7401.

Xiao, E., and Houser, D. (2009). Avoiding the sharp tongue: Anticipated written messages promote fair economic exchange. *Journal of Economic Psychology*, **30**(3), 393–404.

A Appendix

A.1 Instructions (Translation from Italian)

PART A: General

Thank you for taking the time to attend this session. If you have any questions, please raise your hand and one of the experimenters will assist you. You are not allowed to talk to anyone else in the room except for the experimenters.

You will receive a show-up fee of €2.50 for taking part in this session. In addition, you have the opportunity to earn more money depending on the decisions that you and others make during the session. At the end of the session, you will personally be paid the sum of your show-up fee and earnings in private.

The experiment will take place on a computer where you will be paired with a different participant at each period. There will be a total of ten periods. At no point during or after the experiment will you know the identities of participants that you are paired with across the periods.

PART A: Decision tasks - NC

At the very beginning, the computer will randomly assign you either the role of X or Y. Once this assignment is complete, you will remain in that role for the remainder of the session. If you are assigned the role of X, you will be paired with a participant assigned the role of Y, and vice-versa. Your earnings will depend on the decisions that you make in your pair.

The session will be divided into two sections of 5 periods. When the first five periods are over, you will receive instructions for periods 6–10. Therefore, the following decision tasks relate ONLY to the first five periods.

All participants will be endowed with a sum of 10 Experimental Currency Units (ECU) at the start of each period. On the computer screen, participant X will decide how much of his or her endowment to send to participant Y by choosing one the following eleven options:

0 ECU	1 ECU	2 ECU	3 ECU	4 ECU	5 ECU	6 ECU	7 ECU	8 ECU	9 ECU	10 ECU

The choice of participant X is denoted x. The amount x will be multiplied by a factor of 2 before being sent to participant Y, so that participant Y receives $2x$. Not knowing the actual choice of participant X, for each of the eleven possible x choices of participant X, participant Y has to decide on an amount y to send to participant X from his or her total wealth, that is, the initial endowment of 10 ECU plus double the amount sent by participant X. Participant Y will thus fill in the y values in a table similar to the one below:

x	0	1	2	3	4	5	6	7	8	9	10
$2x$	0	2	4	6	8	10	12	14	16	18	20
$10+2x$	10	12	14	16	18	20	22	24	26	28	30
y	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

The only restrictions on the y values is that they must be whole numbers. Otherwise, participant Y can fill in any amount ranging from 0 ECU to his or her maximum wealth, indicated by the value of $10 + 2x$ at each column in the table.

Participant$X$'s choice $\rightarrow$ Participant$Y$'s decisions.

PART A: Decision tasks - OSC

[Decision task text as in NC above]

A Message

Participant Y has the option to send a message(s) to participant X prior to deciding the amounts y corresponding to each of the eleven possible x choices of participant X. However, the message(s) will be after participant X has chosen the amount x to send to participant Y. The following sequence illustrates the chronology of events:

$$X \text{ chooses} \rightarrow \text{optional message(s) from } Y \text{ to } X \rightarrow Y\text{'s decisions}$$

There will be a message window on the computer screen where participant Y can write a message(s) to participant X within the two minute time-gap between participant X's choice and participant Y's decision. If participant Y does not intend to send a message(s) to participant X, then he or she can click on the button labeled "no message" in the computer screen. If this happens, then participant X will be notified that participant Y has chosen not to send any message(s). At any point within the allotted two minutes, participant Y can send a message(s) to participant X regardless of whether he or she had earlier opted not to do so.

In the message(s), participant Y is not allowed to identify him or herself. Therefore, he or she cannot include personal details such as name, gender, appearance, age, address, phone number, and program or year of study. In addition, the use of offensive language is not allowed. (Experimenters will monitor the message(s). Violations (to the discretion of the experimenters) will result in participant Y forfeiting the €2.50 show-up fee and leaving the session with no earnings. The paired participant X will receive the average amount received by other X participants.) Apart from these restrictions, participant Y may say anything that he or she wishes in the message(s).

PART A: Decision tasks - TSC

[Decision task text as in NC above]

Messages

Both participant X and participant Y have the option of sending messages to each other prior to participant Y deciding the amounts y corresponding to each of the eleven possible x choices of participant X. However, the messages will be after participant X has chosen the amount x to send to participant Y. The following sequence illustrates the chronology of events:

$$X \text{ chooses} \rightarrow \text{optional message(s) between } X \text{ and } Y \rightarrow Y\text{'s decisions}$$

There will be a message window on the computer screen where both participant X and participant Y can send messages to each other within the two minute time-gap between participant X's choice and participant Y's decisions. If either participant X or participant Y does not intend to send a message(s) to the other, then he or she can click on the button labeled "no message" in the computer screen. If this happens, then then the paired participant will be notified that either participant X or participant Y has chosen not to send any message(s). At any point within the allotted two minutes, participant X and participant Y can send a message(s) to the paired participant regardless of whether they had earlier opted not to do so.

In the message(s), both participant X and participant Y are not allowed to identify themselves. Therefore, they cannot include personal details such as name, gender, appearance, age, address, phone number, and program or year of study. In addition, the use of offensive language is not allowed. (Experimenters will monitor the message(s). Violations (to the discretion of the experimenters) will result in the violating participant forfeiting the €2.50 show-up fee and leaving the session with no earnings. The paired participant will receive the average amount received by other X or Y participants.) Apart from these restrictions, both participant X and participant Y may say anything that they wish in the messages.

PART A: Earnings - General

Out of the five periods, one period will be randomly selected for payment. ECU will be exchanged at a rate of 3 ECU = €1. The earnings in the randomly selected period will constitute half of the earnings from the experiment, the other half having being determined in periods 1–5. Therefore, final payments at the end of the experiment for each participant X and participant Y will be the sum of the show-up fee, 0.5 × (earnings in periods 1–5), and 0.5 × (earnings in periods 6–10).

PART B: General

The following instructions relate to the second section of the experiment (periods 6–10). If you were assigned the role of X or Y in periods 1–5, you remain in this role for the remainder of the experiment.

You will be paired with a different participant at each period, and at no point during or after the experiment will you know the identities of participants that you are paired with across the periods. Your earnings will depend on the decisions that you make in your pair.

PART B: Decision tasks - NC

Participant X will choose one of two actions – *up* or *down* – from the following matrix:

	left	*right*
up	15, 15	0, 30
down	30, 0	10, 10

where numbers in the matrix represent ECU. Not knowing the action chosen by participant X, participant Y will choose an action – *left* or *right* – from the same matrix. The payoff at each period is determined as follows:

- If participant X chooses *up* and participant Y chooses *left*, then each gets 15 ECU.
- If participant X chooses *up* and participant Y chooses *right*, then participant X gets 0 ECU and participant Y gets 30 ECU.
- If participant X chooses *down* and participant Y chooses *left*, then participant X gets 30 ECU and participant Y gets 0 ECU.
- Finally, if participant X chooses *down* and participant Y chooses *right*, then each gets 10 ECU.

Participant X's choice $\rightarrow$ Participant Y's choice.

PART B: Decision tasks - OSC

[Decision task text as in NC above]

A Message

Participant Y has the option to send a message(s) to participant X prior to choosing an action. However, the message(s) will be after participant X has chosen an action. The following sequence illustrates the chronology of events:

X chooses an action $\rightarrow$ optional message(s) from Y to X $\rightarrow$ Y chooses an action

There will be a message window on the computer screen where participant Y can write a message(s) to participant X within the two minute time-gap between participant X's choice and participant Y's choice. If participant Y does not intend to send a message(s) to participant X, then he or she can click on the button labeled "no message" in the computer screen. If this happens, then participant X will be notified that participant Y has chosen not to send any message(s). At any point within the allotted two minutes, participant Y

can send a message(s) to participant X regardless of whether he or she had earlier opted not to do so.

In the message(s), participant Y is not allowed to identify him or herself. Therefore, he or she cannot include personal details such as name, gender, appearance, age, address, phone number, and program or year of study. In addition, the use of offensive language is not allowed. (Experimenters will monitor the message(s). Violations (to the discretion of the experimenters) will result in participant Y forfeiting the €2.50 show-up fee and leaving the session with no earnings. The paired participant X will receive the average amount received by other X participants.) Apart from these restrictions, participant Y may say anything that he or she wishes in the message(s).

PART B: Decision tasks - TSC

[Decision task text as in NC above]

Messages

Both participant X and participant Y have the option of sending messages to each other prior to participant Y choosing an action. However, the messages will be after participant X has chosen an action. The following sequence illustrates the chronology of events:

X chooses an action $\rightarrow$ optional message(s) between X and Y $\rightarrow$ Y chooses an action

There will be a message window on the computer screen where both participant X and participant Y can send messages to each other within the two minute time-gap between participant X's choice and participant Y's choice. If either participant X or participant Y does not intend to send a message(s) to the other, then he or she can click on the button labeled "no message" in the computer screen. If this happens, then then the paired participant will be notified that either participant X or participant Y has chosen not to send any message(s). At any point within the allotted two minutes, participant X and participant Y can send a message(s) to the paired participant regardless of whether they had earlier opted not to do so.

In the message(s), both participant X and participant Y are not allowed to identify themselves. Therefore, they cannot include personal details such as name, gender, appearance, age, address, phone number, and program or year of study. In addition, the use of offensive language is not allowed. (Experimenters will monitor the message(s). Violations (to the discretion of the experimenters) will result in the violating participant forfeiting the €2.50 show-up fee and leaving the session with no earnings. The paired participant will receive the average amount received by other X or Y participants.) Apart from these restrictions, both participant X and participant Y may say anything that they wish in the messages.

PART B: Earnings - General

Out of the five periods, one period will be randomly selected for payment. ECU will be exchanged at a rate of 3 ECU = €1. The earnings in the randomly selected period will constitute half of the earnings from the experiment, the other half having being determined in periods 1–5. Therefore, final payments at the end of the experiment for each participant X and participant Y will be the sum of the show-up fee, 0.5 × (earnings in periods 1–5), and 0.5 × (earnings in periods 6–10).